

Carbon Sequestration and Water Quality

Tom Godbold

Michigan Department of Environmental Quality

Office of Geological Survey

Geologic Carbon Sequestration what is it.

Containment of a Carbon dioxide
in deep geologic formations
through

Enhanced oil recovery

Brine aquifer injection

Concern #1

- ▶ Many of the CO₂ streams contain mercury, sulfur compounds, and other constituents.
- ▶ Solution - remove these constituents and inject relatively pure CO₂.

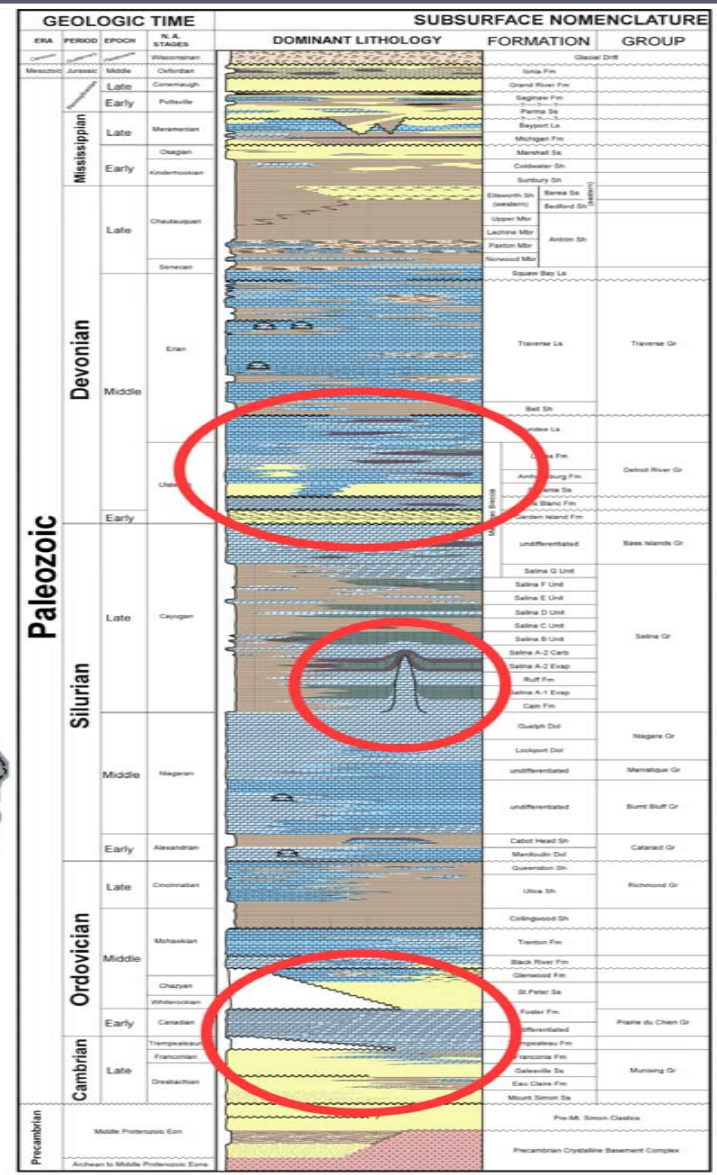
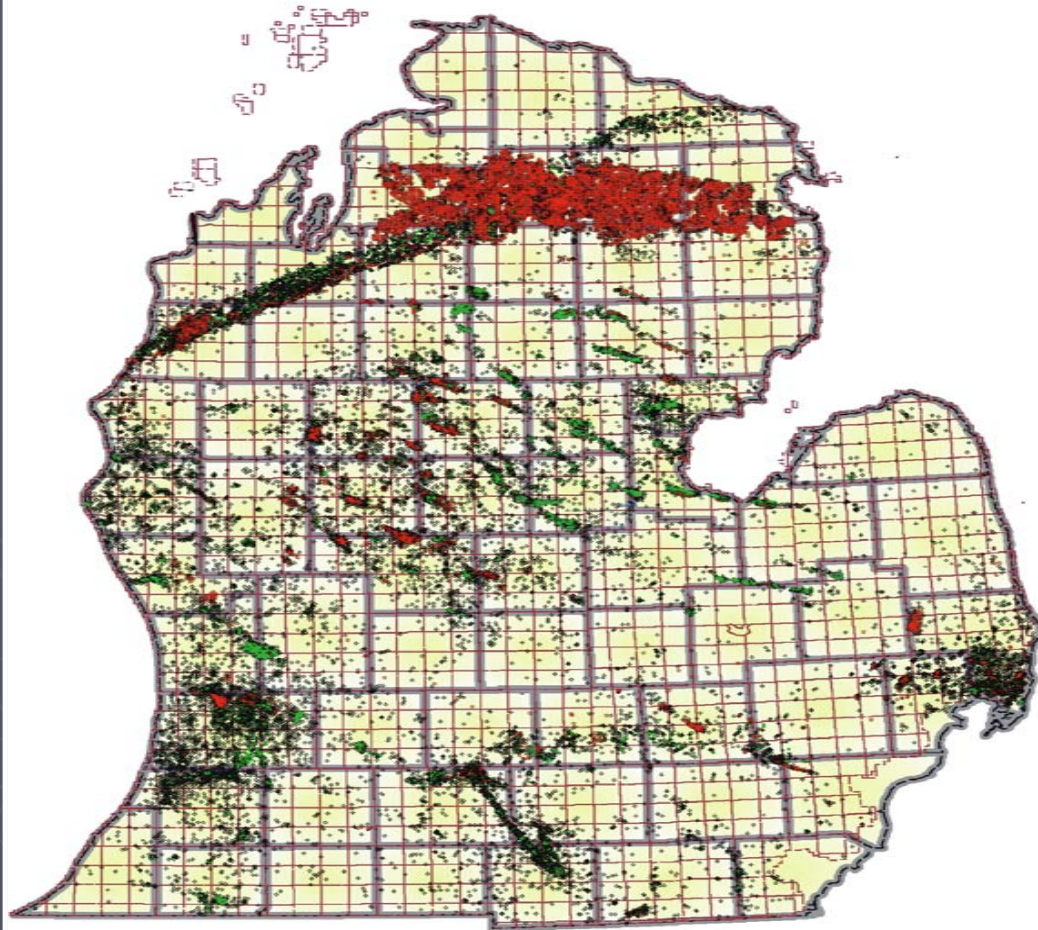
Steps to assure water quality

- 1. Inject a pure stream of CO₂.



Concern #2

- ▶ Are previously drilled wells plugged sufficiently to prevent CO₂ from migrating vertically to the surface?



Dr. David Barnes, Western Michigan Univ.

Well drilling, what we know.

- ▶ Mid 1800's - Oil and gas drilling and production began in Michigan.
- ▶ 1927 - First oil and gas permitting.
- ▶ 1941 - First natural gas storage began.
- ▶ 1947 – First secondary recovery/pressure maintenance.
- ▶ 1968 – First underground injection control.

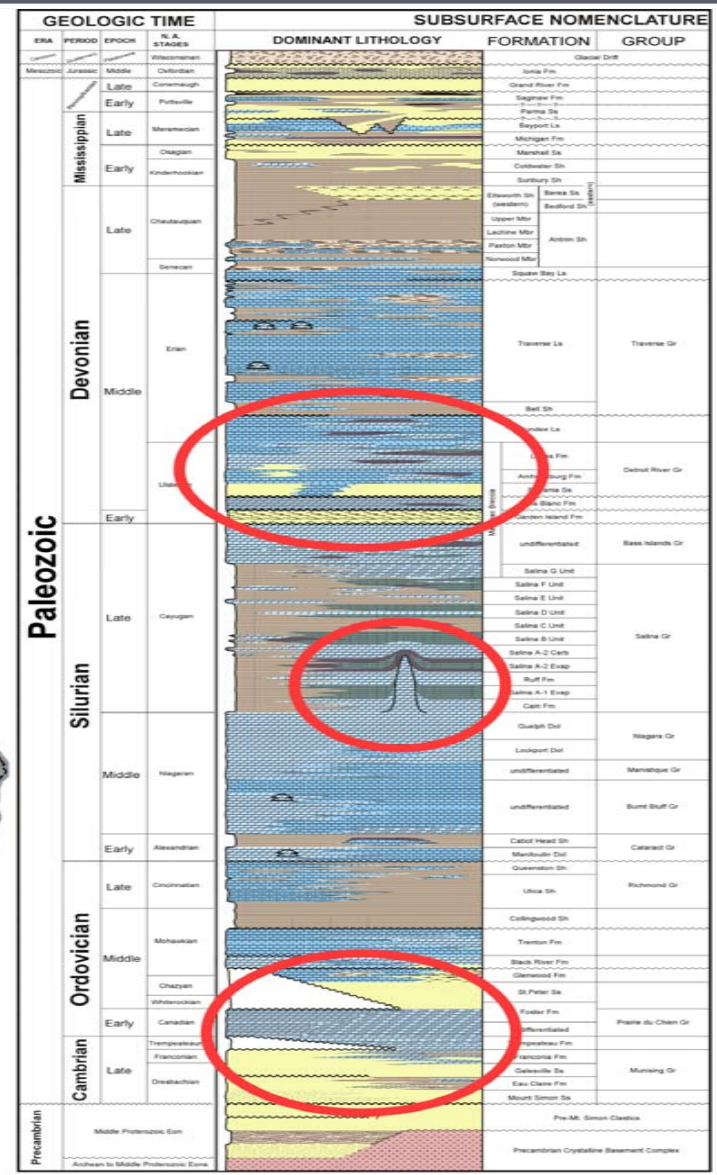
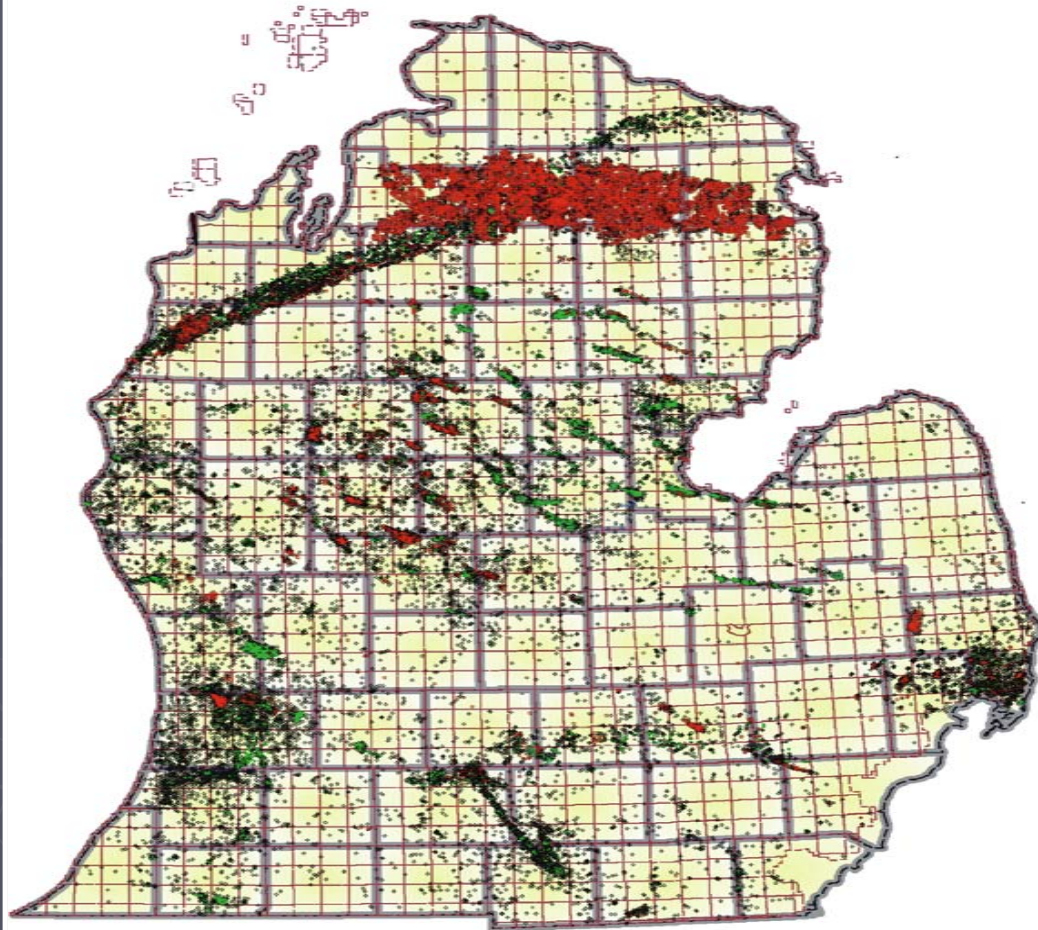
Pre-permit wells

- ▶ Wells were drilled in Michigan for roughly 75 years prior to any permitting requirements.



We don't know how many wells were drilled or exactly where they were drilled.

We do know approximately where they were drilled and that they were relatively shallow wells, less than 3000 feet deep.



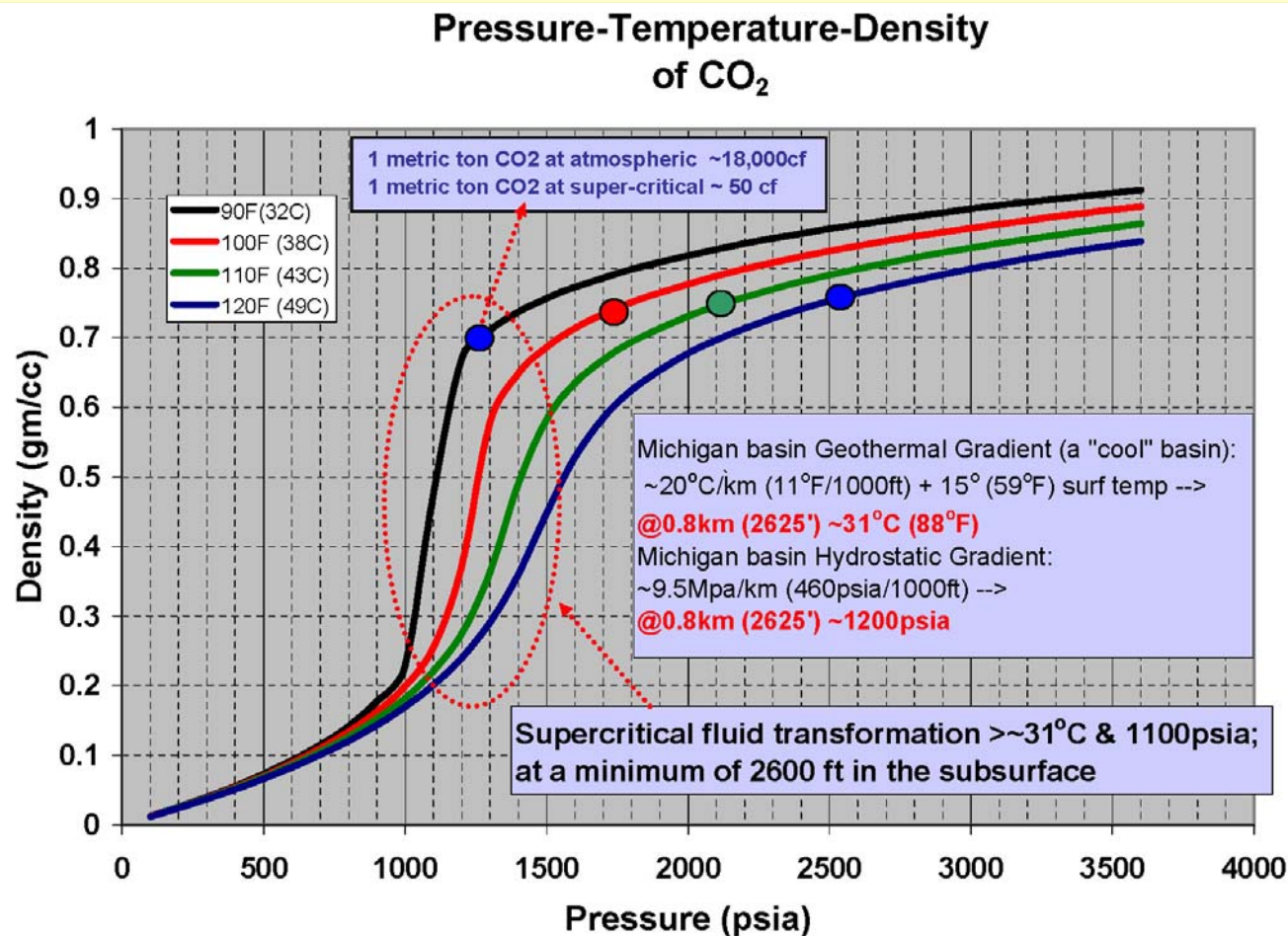
Dr. David Barnes, Western Michigan Univ.

Steps to assure water quality

- ▶ 1. Inject a pure stream of CO₂.
- ▶ 2. Inject into deep formations.

Basic Requirements for GCS in Geological Media

Subsurface pressure and temperature to maintain CO₂ in a supercritical state – Defines minimum depth in the subsurface



- P-T-D at 2800 ft
- P-T-D at 3750 ft
- P-T-D at 4600 ft
- P-T-D at 5500 ft

Dr David Barnes

Western Mich. Univ.

Well drilling, what we know.

- ▶ Mid 1800's - Oil and gas drilling and production began in Michigan.
- ▶ 1927 - First oil and gas permitting.
- ▶ 1941 - First natural gas storage began.
- ▶ 1947 – First secondary recovery/pressure maintenance.
- ▶ 1968 – First underground injection control.

Concern #3

- ▶ *"Filled the bottom hole from the total depth to 1464' using approx. 160 pails of mud. Bridged solidly at 436' and filled to the 6" using 25 pails of mud. The 6" and 8 ¼" drive pipe will remain in the hole for pulling contractors. Hole is covered over safely at the surface."*
 - (from the plugging record of a well plugged in 1951 Total depth of the well is 1782')
- ▶ Older plugged wells may not stand repressurization.
- ▶ Older plugged wells will need to be carefully checked and if necessary replugged to today's standards.

Steps to assure water quality

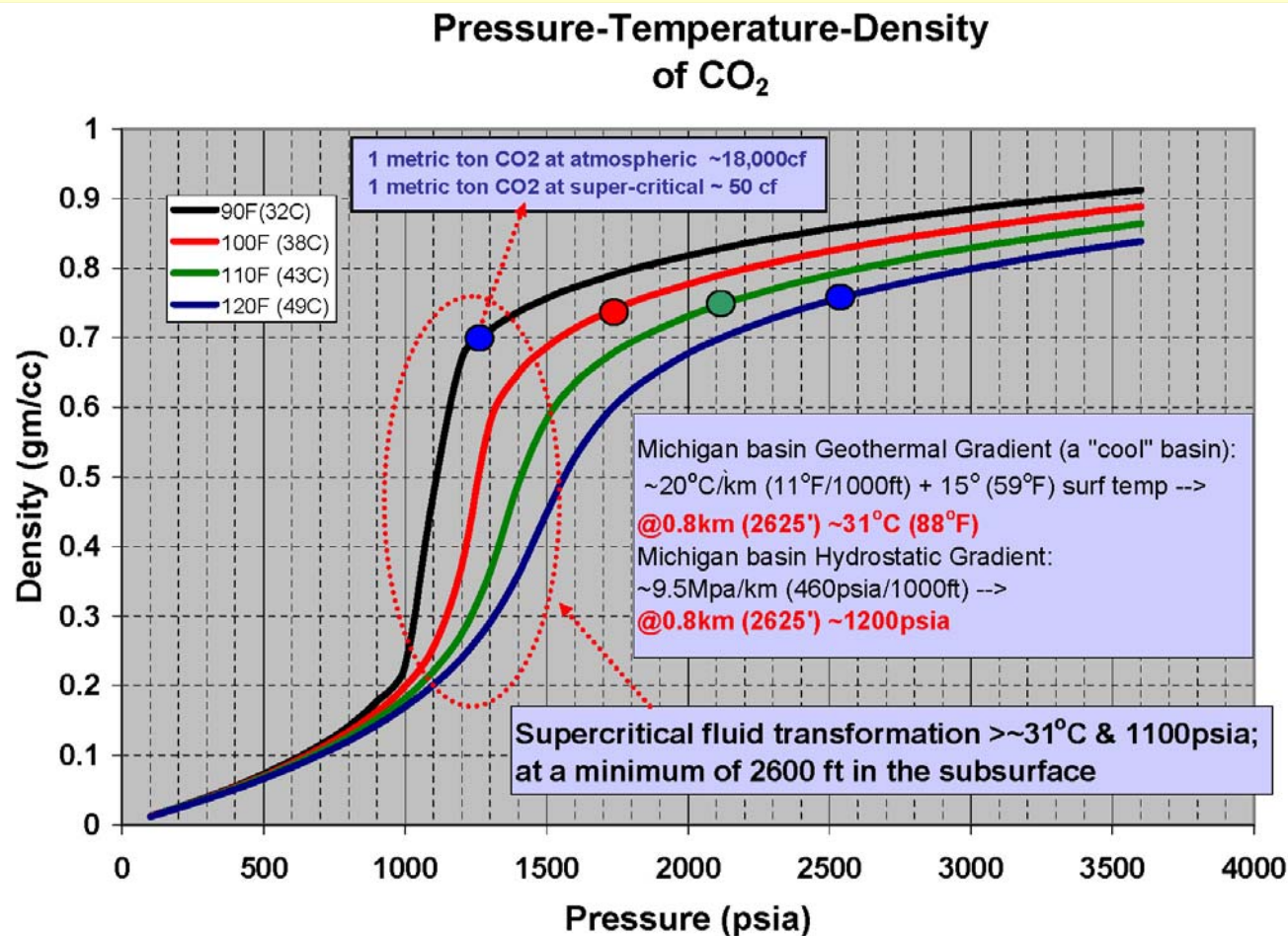
- ▶ 1. Inject a pure stream of CO₂.
- ▶ 2. Inject into deep formations.
- ▶ 3. Check how wells were plugged. Re-plug as necessary

Concern #4

- ▶ With a density of .8gm/cc, CO₂ will be more buoyant than formation brines.
- ▶ Solutions:
 - Inject into newer oil and gas reservoirs.
 - Inject into deep formations.

Basic Requirements for GCS in Geological Media

Subsurface pressure and temperature to maintain CO₂ in a supercritical state – Defines minimum depth in the subsurface



- P-T-D at 2800 ft
- P-T-D at 3750 ft
- P-T-D at 4600 ft
- P-T-D at 5500 ft

Dr David Barnes

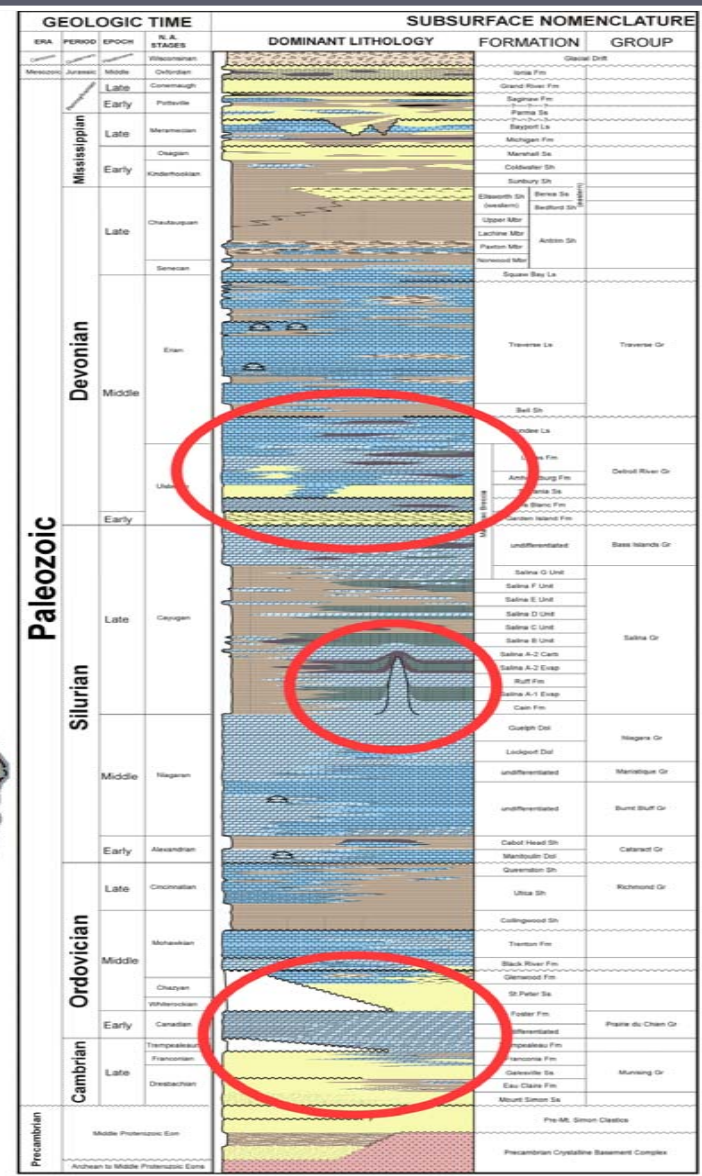
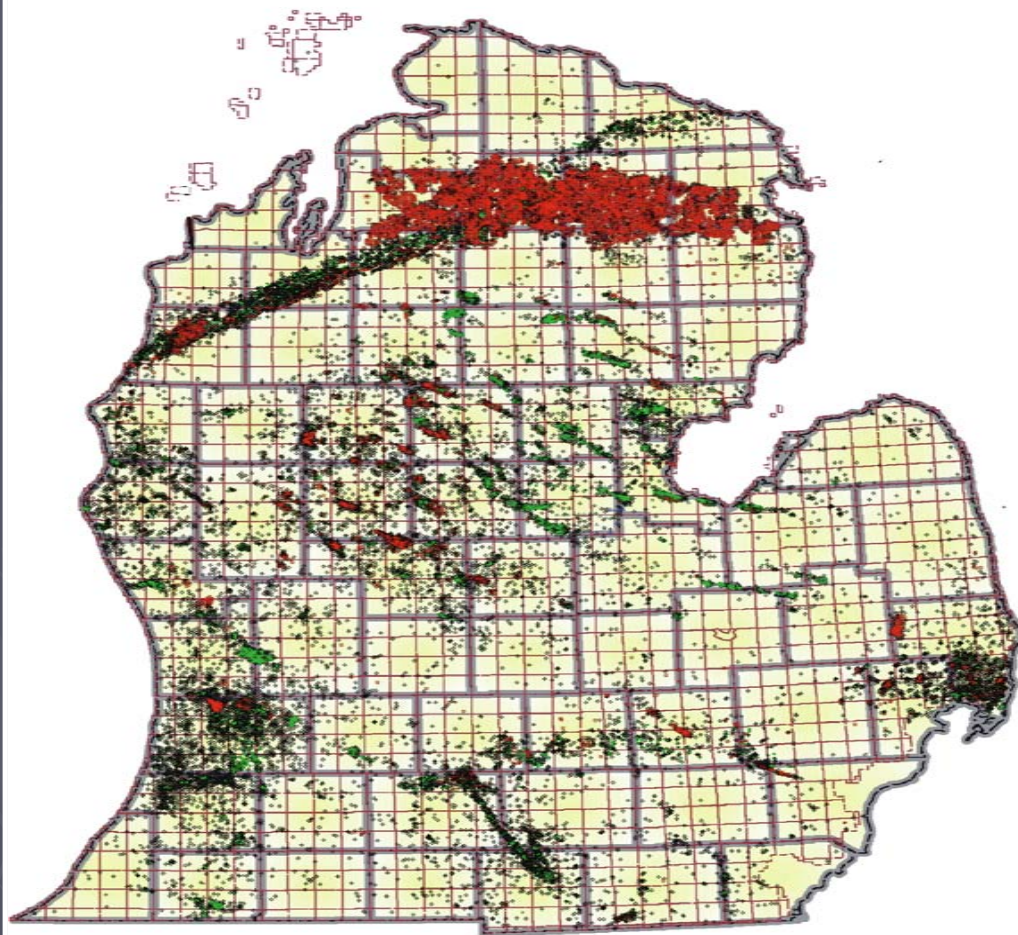
Western Mich. Univ.

Oil and gas reservoirs

- ▶ Oil and gas reservoirs held fluids at the same pressures likely to be experienced with CO₂ sequestration.
- ▶ Concerns:
- ▶ Casings need to be adequate to function in a higher pressure environment
- ▶ There must be adequate cement to isolate CO₂ in the target formation.
- ▶ Although we would expect both conditions in wells drilled in the 1960's or later, every well needs a thorough review.

Saline aquifer sequestration

- ▶ Capable of holding a much larger volume of CO₂
- ▶ No well defined trapping boundaries
- ▶ Salt, shale, and tight limestone formations would prevent vertical movement of CO₂



Dr. David Barnes, Western Michigan Univ.

Natural Fractures

- ▶ Michigan is considered a stable basin.
- ▶ Movement of mineralized fluids tends to seal fractures especially in salt formations.

Steps to assure water quality

- ▶ 1. Inject a pure stream of CO₂.
- ▶ 2. Inject into deep formations.
- ▶ 3. Check how wells were plugged. Re-plug as necessary.

Summary

- ▶ Like gas storage, sequestration of CO₂ into oil and gas reservoirs is being done now and can be done safely.
- ▶ The Michigan Basin appears to have excellent potential for sequestration of CO₂ into deep brine aquifers. Additional research is ongoing.

Thank You

Questions

